European Journal of Obstetrics and Gynecology 297 (2024) 50–58

Contents lists available at ScienceDirect

European Journal of Obstetrics & Gynecology and Reproductive Biology

journal homepage: www.journals.elsevier.com/european-journal-of-obstetrics-and-gynecology-and-reproductive-biology

Review article

The great debate: Surgical outcomes of laparoscopic versus laparotomic myomectomy. A meta-analysis to critically evaluate current evidence and look over the horizon

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ARTICLE INFO

Keywords:
Uterine Myomectomy
Laparoscopy
Laparotomy
Uterine Leiomyomas

ABSTRACT

Myomectomy is one of the most common surgical procedure in the field of gynecology. However, the role of laparoscopic myomectomy is still debated for many factors, including surgical considerations, safety and fertility concerns, long-term outcomes, and cost-related issues. The aim of this study is to evaluate the surgical peri- and post-operative outcomes of laparoscopic and abdominal myomectomy. A systematic search for studies was performed up to June 2023 through MEDLINE, Pubmed, Embase. Studies reporting the comparison of surgical and obstetrical outcomes in laparoscopic versus laparotomic myomectomy were included for the following outcomes: time of surgery, estimated blood loss, decrease of postoperative hemoglobin, hospital stay, intra-operative complication rates, postoperative complications rates, postoperative analgesic use, postoperative pain at 24 h and pregnancy rate. The *meta*-analysis was performed using the Cochrane Review software. Fifty-six relevant articles were retrieved through the process of evidence acquisition. Eleven articles met inclusion criteria, for a total of 2,133 patients undergoing laparoscopic or laparotomic myomectomy. The estimated blood loss [standard mean differences (SMD) 0.72, IC 95 % 0.22 to 1.22], the hospital stays [SMD 3.12, IC 95 % 0.57 to 4.28], were significantly lower in laparoscopic than in open group. No statistically significant difference in intra-operative and post-operative complication rates, in pregnancy rate and others obstetrical outcomes between two surgical approaches were found. The findings of present metanalysis suggest that laparoscopic myomectomy offers multiple benefits, including reduced blood loss, shorter hospital stays, and less postoperative analgesic need, without a significant increase in complication rates and similar results in obstetrical outcomes when compared to abdominal myomectomy. However, the presence of few randomized studies on selected population may limit the generalizability of the findings to the entire population. Therefore, more well-designed studies or large population program data to draw definitive conclusions are therefore warranted.

Abbreviations: UL, Uterine leiomyomas; FIGO, International Federation of Gynecology and Obstetrics; MeSH, Medical Subject Headings; BMI, Body mass index; SMD, Standardized mean difference; OR, Odds ratio; CI, Confidence interval; VAS, Visual analog scale.

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https://doi.org/10.1016/j.ejogrb.2024.03.045
Received 22 February 2024; Received in revised form 28 March 2024; Accepted 31 March 2024
Available online 1 April 2024

Introduction

Uterine leiomyomas (UL) are the most common benign pelvic tumors in reproductive aged women [1–4]. UL can be classified according to International Federation of Gynecology and Obstetrics (FIGO) classification [5–7] as submucosal, intramural, subserosal, or transmural, depending on the location of occurrence: intracavitary, inside the myometrium or in the serosa of the uterus.

Clinically, UL can be asymptomatic or symptomatic. Symptomatic patients represent 25 % of women with UL and only these cases with symptoms or complications need a treatment [8]. Very common symptoms/signs referred by UL patients are heavy menstrual bleeding, lower abdominal pain and distention, micturition and defecation difficulties, and infertility. If medical treatment is ineffective, surgery may be necessary [9]. Hysterectomy may be considered as an option for patients who no longer have a desire for fertility. On the contrary, myomectomy is the typical operative management for patients who have a desire for fertility or refuse hysterectomy. Although symptomatic UL are widely treated by laparotomic myomectomy, laparoscopic myomectomy is a more attractive approach. The reasons for growing interest in laparoscopy rather than laparotomy are its pros, like minimal surgical access, fast recovery, less pain, and shorter hospital stay [10,11]. However, laparoscopic myomectomy has some cons, such as its need for longer operation times, together with more training for surgeons compared to laparotomic myomectomy [11,12]. Considering these points, the aim of this review and *meta*-analysis is to evaluate the surgical peri and postoperative outcomes and obstetrical outcomes of these two approaches in order to support surgeons in making a more aware choice, when treating UL.

Materials and methods

Search strategy

A search was performed up to June 2023 by two authors (I.C., T.G.A.) independently, within MEDLINE, Pubmed, Embase, selecting all relevant studies evaluating the comparison of surgical outcomes in women with UL after laparoscopic myomectomy and laparotomic myomectomy. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [13] and the Cochrane Handbook for Systematic Reviews of Interventions were followed during the development of this systematic review and *meta*-analysis.

The process of evidence acquisition combined the following keywords and their Medical Subject Headings (MeSH) terms: “Uterine Myomectomy” (MeSH Unique ID: D063186) combined with “Laparoscopy” (MeSH Unique ID: D010535) AND/OR “Laparotomy” (MeSH Unique ID: D007813).

Article abstracts, full text articles and cross-referenced studies identified from retrieved articles were screened independently by two review authors to identify studies that potentially meet the aims of this systematic review and *meta*-analysis. All duplicate records were removed.

Selection of studies and methodologic quality assessment

The full texts of these potentially eligible articles were retrieved and independently assessed for eligibility by other two review team members. Any disagreement between them over the eligibility of particular articles was resolved through discussion with a third (external) collaborator. Two authors independently extracted data from articles about study characteristics and included populations, type of intervention and outcomes, using a pre-piloted standard form in order to ensure consistency. Any discrepancies were identified and resolved through discussion (with a third external collaborator where necessary).

Key criteria for inclusion were: 1) original studies published in English, in peer-reviewed journals; 2) studies comparing laparoscopic and laparotomic approaches in patients undergoing myomectomy; 3) studies reporting on at least one of the outcomes measures of this *meta*-analysis.

The selected studies were comprehensively examined, and relevant data extracted for each paper. The selected information included: author, year of publication, main objective, study design (retrospective or prospective, mono or multicentric), mean age of patients, body mass index (BMI) of patients, number of UL removed, size of largest UL, localization of UL removed, estimated blood loss, operative time, hospital stay, intraoperative and post-operative complication rate, decrease of postoperative hemoglobin, pregnancy rate (the success rate for getting pregnant), uterine rupture, type of delivery, abortions.

The two authors (I.C., E.D.A.) carried out data extraction and quality assessment from all the retrieved studies based on full-text articles. Discrepancies between the investigators were resolved by consensus. The studies were then classified qualitatively according to the guidelines published in the Cochrane Handbook for Systematic Reviews of Interventions [14]. The risk of bias of non randomized studies included in the *meta*-analysis was assessed according to the Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) [15]. The risk of bias of randomized studies included in the *meta*-analysis was assessed according to the Risk of Bias in randomized Trials [16]. The review had been prospectively registered in International Prospective Register of Systematic Reviews (PROSPERO) with the registration number CRD42023462941.

Outcomes

The primary aim was to evaluate surgical outcomes in women with UL after laparoscopic myomectomy and laparotomic myomectomy, considering the following parameters: 1) time of surgery (minutes); 2) estimated blood loss (mL); 3) decrease of postoperative hemoglobin (g/dL); 4) hospital stay; 5) intra-operative complication rates; 6) post-operative complications rates; 7) postoperative analgesic use; 8) post-operative pain at 24 h; 9) pregnancy rate and other obstetrical outcomes.

Statistical analysis

The data were analyzed using Cochrane Review software (Review Manager version 5.4 for Mac). Continuous outcomes were expressed as standardized mean difference (SMD). Dichotomous outcomes from each study were expressed as an odds ratio (OR) with a 95 % confidence interval (CI). Heterogeneity between studies was reported with the I^2 statistic. A random-effects *meta*-analysis model was used if any heterogeneity was detected, whereas a fixed-effect model was used if no heterogeneity was identified. We decided to examine publication bias with Egger’s test and funnel plots if the number of studies was 10 or above, since these analyses are underpowered otherwise.

Results

Study selection

The study selection is illustrated in Fig. 1.: the search resulted in 56 relevant articles. Eleven articles met inclusion criteria, for a total of 2133 patients [17–27]. The remaining studies were not included in the *meta*-analysis because they did not meet the inclusion criteria.

Study characteristics and patient characteristics

The characteristics of included studies are detailed in Table 1 and Table 2. Among the 11 studies included: 1 study (9 %) was prospective observational [17], 3 (27.3 %) were retrospective observational [18–20]

and 7 (63.7 %) were randomized trials [21–27]. One study was published in 1995 [22], 1 study was published between 2000 and 2005 [26], 6 studies were published between 2006 and 2009 [17,21,23,24,25,27] and 3 studies were published after 2009 [18–20]. Of the total of 2133 patients, 1290 (60.5 %) underwent laparoscopic myomectomy, 843 (39.5 %) underwent laparotomic myomectomy. Of the 11 included studies, 4 studies reported the location of dominant UL removed [18,23,25,26]. Of 551 UL, 25 (4.6 %) were pedunculated, 192 (34.8 %) were subserous, 53 (9.6 %) were subserous-intramural, 276 (50.1 %) were intramural and 5 (0.9 %) were intramural-submucosal. 7 studies did not describe data about dominant UL type [17,19–22,24,27]. 10 studies reported the mean number of UL removed, for a total of 2081 patients [17–24,26,27]: in 3 studies the mean was less 2 ULs removed (789 patients, 38 %) [17–19], and in 7 studies it was greater than or equal to 2 ULs removed (1292 patients, 62 %) [20–24,26,27], with a maximum of 3.7 ULs. One study reported no data [25]. All studies reported the maximum diameter of the largest UL (cm), for a total of 2133 patients. Five studies [17,22–24,27] reported a dominant UL size less to 7 cm (443 patients, 20,7%), 6 studies [18–21,25,26] reported a dominant UL size greater than or equal to 7 cm (1,690 patients, 79.3 %). Laparoscopic and laparotomic surgical procedures were conducted by the same surgeons in 8 of the 11 studies included in the *meta*-analysis [17,19,22–27]. In the remaining three studies [18,20,21], it is not specified whether the same operators performed both surgical procedures. In addition, 8 of the 11 studies used a morcellation procedure to extract the myoma in the laparoscopic approach [17–20,22,24,26,27]. No laparoscopic procedures were robot-assisted.

The risk of bias assessment for the included studies is detailed in **Tables S1 and S2**.

Table 1
The characteristics of included studies.

Study Characteristics	Studies (n = 11)	Patients (n = 2133)
Pubblication Year		
Before 2000	1	40 (18.75 %)
2000–2005	1	131 (6.14 %)
2006–2009	6	495 (23.2 %)
After 2009	3	1467 (68.8 %)
Study Design		
Prospective	1	75 (3.52 %)
Retrospective	3	1467 (68.8 %)
Randomized	7	591 (27.7 %)
Geographic location		
Europe	8	1074 (50.3 %)
Asia	3	1059 (49.7)

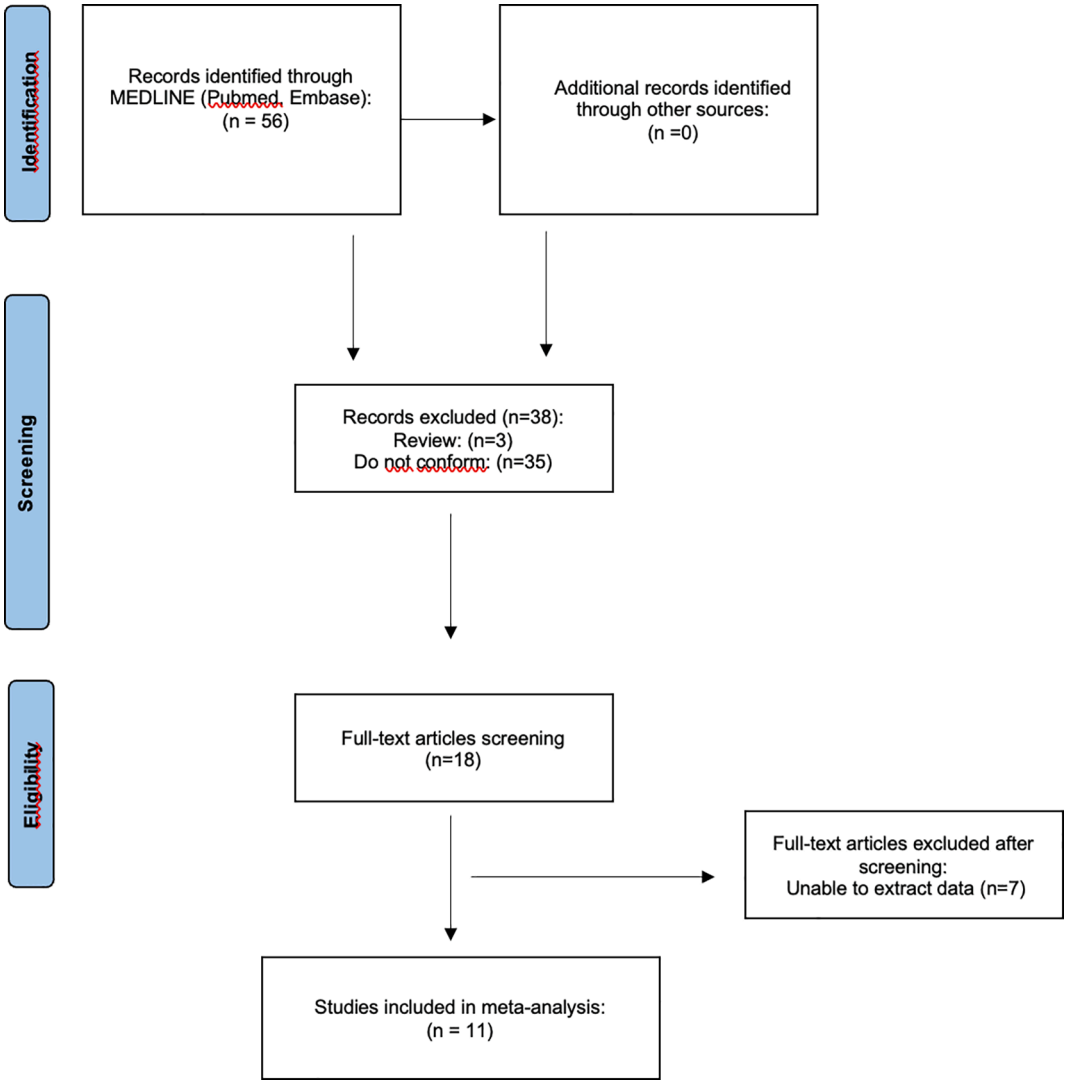

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram.

Table 2
The characteristics of included studies.

Authors	Years	Type of study	Pts	LA	AM	Inclusion criteria	
						Number of myoma	Size of myoma (cm)
Mais	1995	RCT	40	20	20	< 4	<6
Seracchioli	2000	RCT	131	66	65	≥1	≥5
Alessandri	2006	RCT	148	74	74	<4	<7
Sesti	2006	RCT	100	50	50	<5	<10
Holzer	2006	RCT	40	19	21	/	<10
Cicinelli	2008	RCT	80	40	40	<3	<7
Ji Tan	2008	RCT	52	26	26	<3	<10
Kalogiannidis	2009	Obs	75	48	27	≥1	<9
Kotani	2018	Retro	753	474	279	/	/
Ordás	2022	Retro	254	112	142	≥1	≥3
Catanese	2022	Retro	460	361	99	/	/

RCT: Randomized Obs: Observational Retro: Retrospective.

Outcomes

Time of surgery

Ten studies with a total of 1,673 patients (926 in laparoscopic group and 744 in laparotomic group) were included in statistical analysis [17,18,20–27]. One study was excluded from the analysis because does not reported the mean of surgery time [19]. Time of surgery was analyzed in minutes. Non-significant differences were showed for the difference in mean time of surgery between group. A non-significant trend of increase in mean time of surgery was shown in in laparoscopic cohorts. The overall mean difference was −0.35 (95 % CI −0.72 to 0.02, p =.06). Sensitivity analysis was performed according to the study design dividing Randomized (-0.39 (95 % CI −0.91 to 0.14, p =.15) and Non-Randomized (-0.28 (95 % CI −0.97 to 0.41, p =.43)) studies confirming the finding. (Fig. 2).

Estimated blood loss

Seven studies with a total of 1,140 patients (677 in laparoscopic group and 463 in laparotomic group) were included in statistical analysis [17,20–25]. Four studies were excluded from the analysis because did not report the mean of blood loss [18,19,26,27]. The estimated blood loss was analyzed in mL. The overall mean difference was 0.72 (95 % CI 0.22 to 1.22, p =.005) suggesting a reduced blood loss in laparoscopic cohorts. Sensitivity analysis was performed according to the study design dividing Randomized (0.69 (95 % CI −0.21 to 1.59, p =.14)) and Non-Randomized (0.82 (95 % CI 0.49 to 1.15, p <.001)) studies confirming the finding. (Fig. 3).

Decrease of postoperative hemoglobin

Five studies with a total of 455 patients (238 in laparoscopic group and 217 in laparotomic group) were included in statistical analysis [17,23–25,27]. Six studies were excluded from the analysis because did not report the mean of decrease of postoperative hemoglobin [18–22,26]. Decrease of postoperative hemoglobin was analyzed in g/dL.

The overall and sensitivity analysis did not reveal any statistically significant difference between the cohorts concerning the decrease of postoperative hemoglobin.

A non-significant trend in decrease of postoperative hemoglobin level was shown in laparoscopic cohorts. The overall mean difference was 1.07 (95 % CI −0.05 to 2.19, p =.06). Sensitivity analysis was performed according to the study design dividing Randomized (1.28 (95 % CI −0.08 to 2.63, p =.07)) and Non-Randomized (0.26 (95 % CI −0.22 to 0.73, p =.29)) studies confirming the finding. (Fig. 4).

Hospital stay

Eight studies with a total of 1,593 patients (890 in laparoscopic group and 703 in laparotomic group) were included in statistical analysis [17,18,20,23–27]. Three studies were excluded from the analysis because did not report the mean of hospital stay [19,21,22]. The overall mean difference was 3.12 (95 % CI 1.97 to 4.28p <.001) suggesting a reduced hospital stay in laparoscopic cohorts. Sensitivity analysis was performed according to the study design dividing Randomized (4.15 (95 % CI 2.37 to 5.93, p <.001)) and Non-Randomized (2.44 (95 % CI 0.57 to 4.30, p =.01)) studies confirming the finding. (Fig. 5).

Intraoperative complications rate

Five studies with a total of 597 patients (294 in laparoscopic group

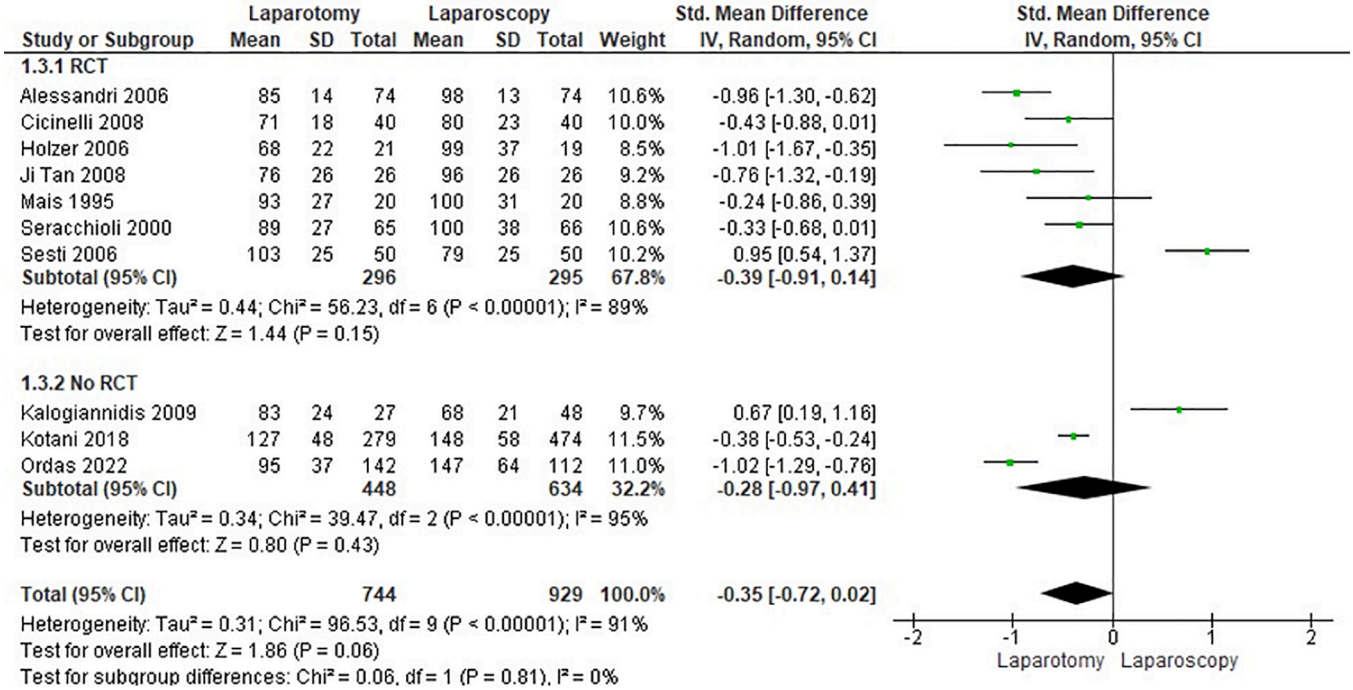

Fig. 2. Forest plot of comparison on time of surgery between laparotomic myomectomy and laparoscopic myomectomy.

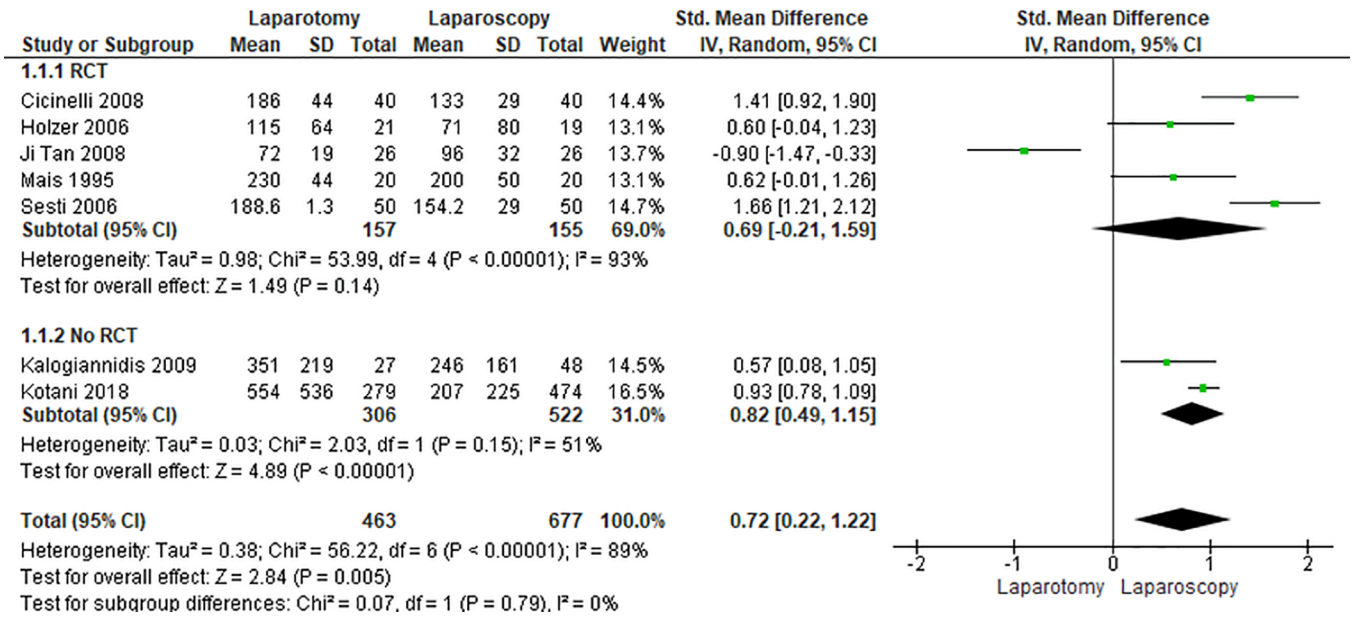

Fig. 3. Forest plot of comparison on estimated blood loss between laparotomic myomectomy and laparoscopic myomectomy.

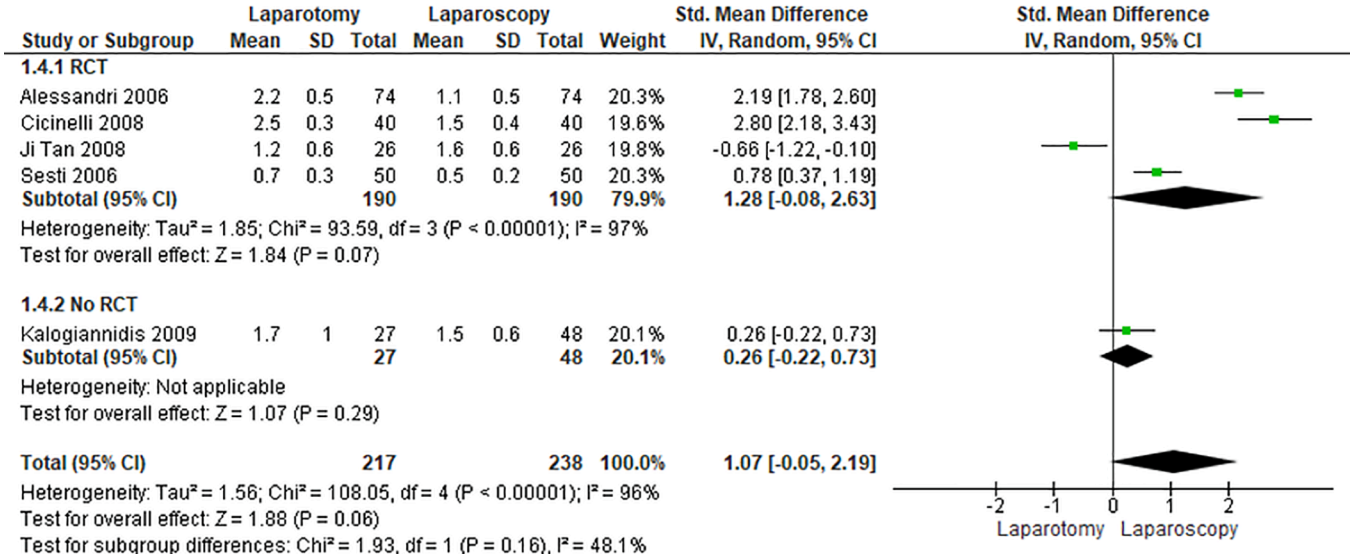

Fig. 4. Forest plot of difference in decrease of postoperative hemoglobin level after laparotomic myomectomy and laparoscopic myomectomy.

and 303 in laparotomic group) were included in statistical analysis [17,18,22,24,27]. Six studies were excluded from the analysis because did not report the occurence of intraoperative complications rate [19–21,22,25,27].

Only one study [18] analyzed intraoperative complications using the Clavien-Dindo classification, not dividing them into grade of severity. In view of the lack of classification in the other studies, the occurrence of complications was considered. The main intraoperative complications were injuries to internal organs such as bowel, uterus, bladder, and vascular injuries.

The analysis did not reveal any statistically significant difference between cohorts in occurrence of intraoperative complications. The OR was 0.89 (95 % CI 0.36 to 2.17p =.80). Sensitivity analysis was performed according to the study design dividing Randomized (0.25 (95 % CI 0.03 to 2.28, p =.22)) and Non-Randomized (1.14 (95 % CI 0.43 to 3.02, p =.79)) studies confirming the finding. (Fig. 6).

Postoperative complications rate

Three studies with a total of 754 patients (493 in laparoscopic group and 261 in laparotomic group) were included in statistical analysis [18,19,22]. 8 studies were excluded from the analysis because did not report the mean of postoperative complications rate [17,20,21,23–27]. One study [18] analyzed postoperative complications using the Claveln-Dindo classification, dividing them into grade of severity. In only one study were postoperative complications recorded in terms of early complications (<30 days, > G2) and long-term complications (>30 days, > G2) [19].

In view of the lack of classification in the other studies, the occurrence of complications was considered. The analysis did not reveal any statistically significant difference between the cohorts concerning postoperative complications rate. The OR was 1.35 (95 % CI 0.72 to 2.52p =.35). Sensitivity analysis was performed according to the study design dividing Randomized (1.00 (95 % CI 0.06 to 17.18, p =.99)) and Non-Randomized (1.37 (95 % CI 0.72 to 2.60, p =.34)) studies confirming the finding. (Fig. 7**).**

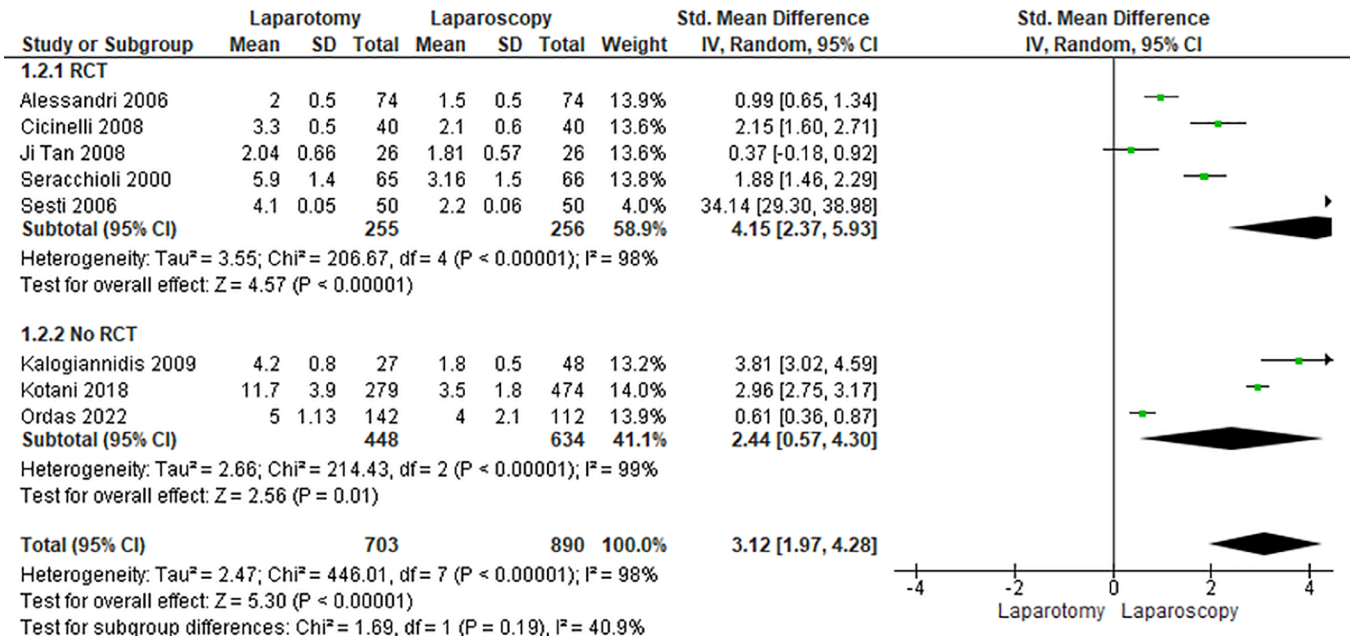

Fig. 5. Forest plot of comparison on length of stay in hospital between laparotomic myomectomy and laparoscopic myomectomy.

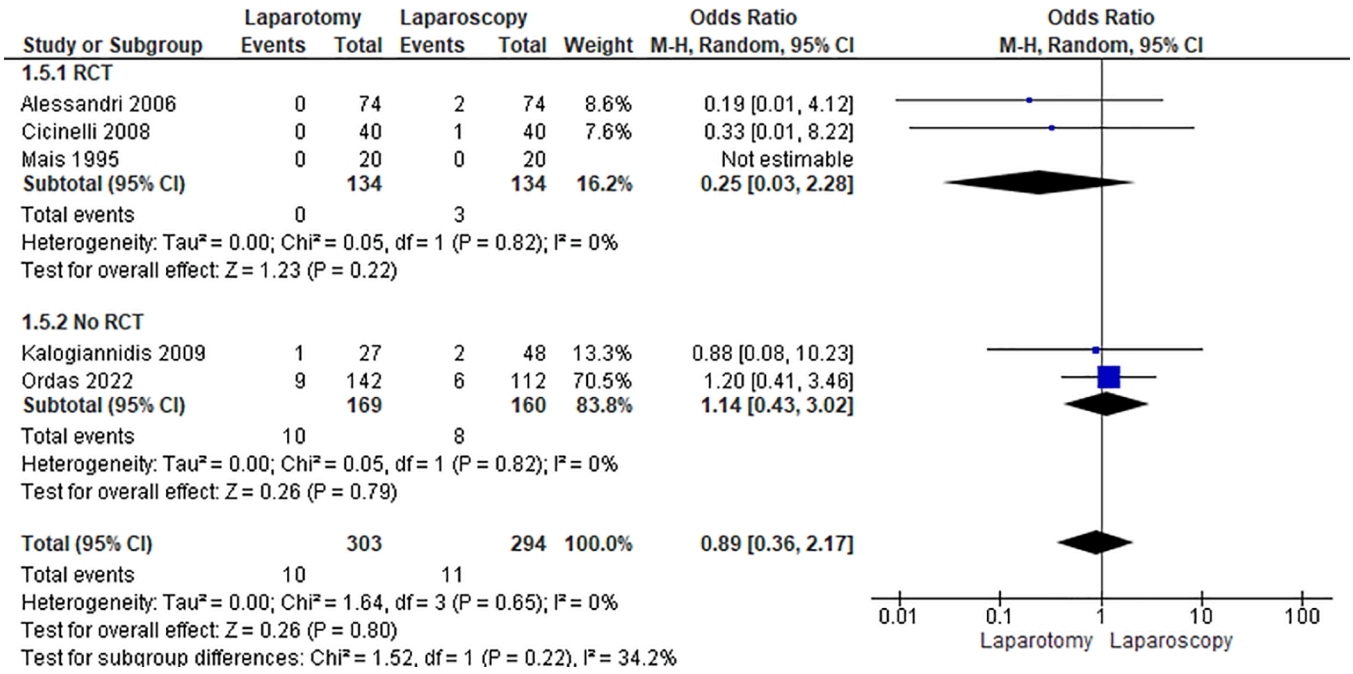

Fig. 6. Forest plot of comparison on intraoperative complications incidence between laparotomic myomectomy and laparoscopic myomectomy.

Postoperative analgesic use

Two studies with a total of 198 patients (98 in laparoscopic group and 100 in laparotomic group) were included in statistical analysis [25,27]. Nine studies were excluded from the analysis because did not report the mean of postoperative analgesic use [17–24,27]. However, one [25] of the two studies reported that all patients in both laparoscopic and laparotomic cohorts assumed analgesics after surgery, making the *meta*-analysis impractical. The other study available reported a statistically significant reduction in the use of analgesics in patients undergoing laparoscopic myomectomy. [27].

Postoperative pain at 24 h

Four studies with a total of 340 patients (169 in laparoscopic group and 171 in laparotomic group) were included in statistical analysis [21,23,25,27]. 7 studies were excluded from the analysis because did not report the mean of postoperative analgesic use [17–20,22,24,27]. Postoperative pain was evaluated with a visual analog scale (VAS). The analysis did not reveal any statistically significant difference between the cohorts concerning postoperative pain at 24 h. The OR was 0.09 (95 % CI −0.23 to 0.41p =.58). (Fig. 8).

Pregnancy rate and obstetrical outcomes

Eight studies were excluded from the analysis because did not report the pregnancy rate [17,19,21–25,27]. Three studies with a total of 1,063 patients (642 in laparoscopic group and 480 in laparotomic group) were included in statistical analysis [18,20,26]. The analysis did not reveal

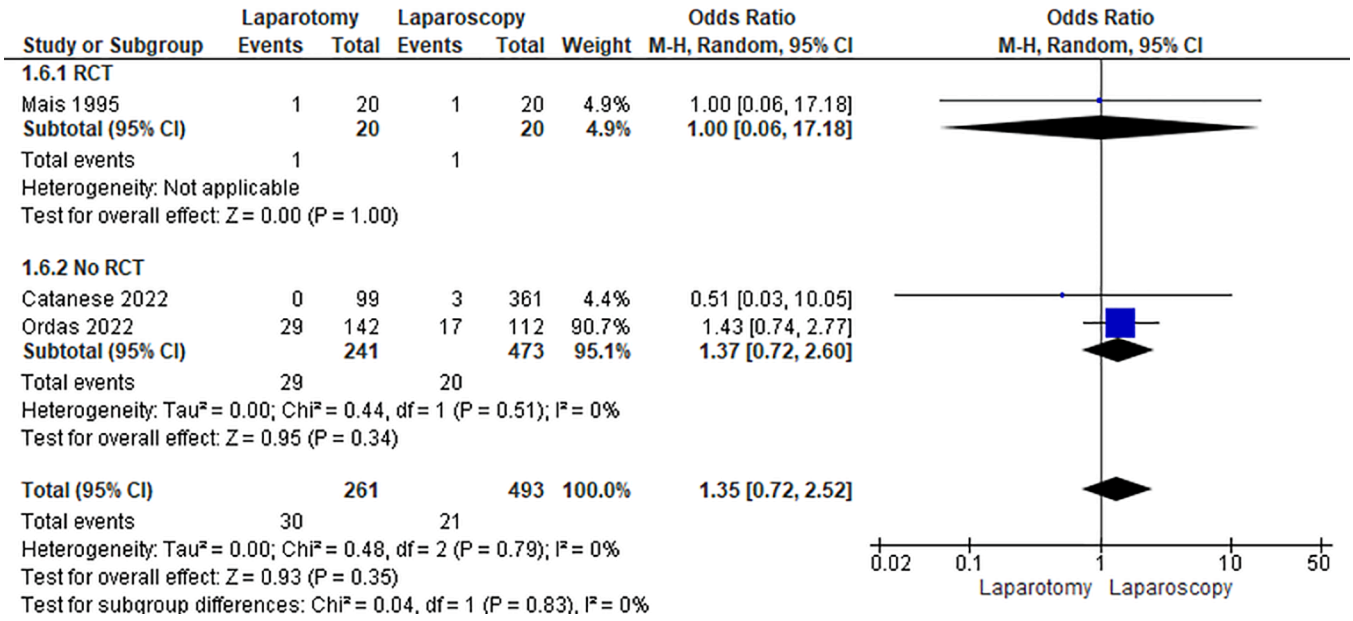

Fig. 7. Forest plot of comparison on postoperative complications incidence between laparotomic myomectomy and laparoscopic myomectomy.

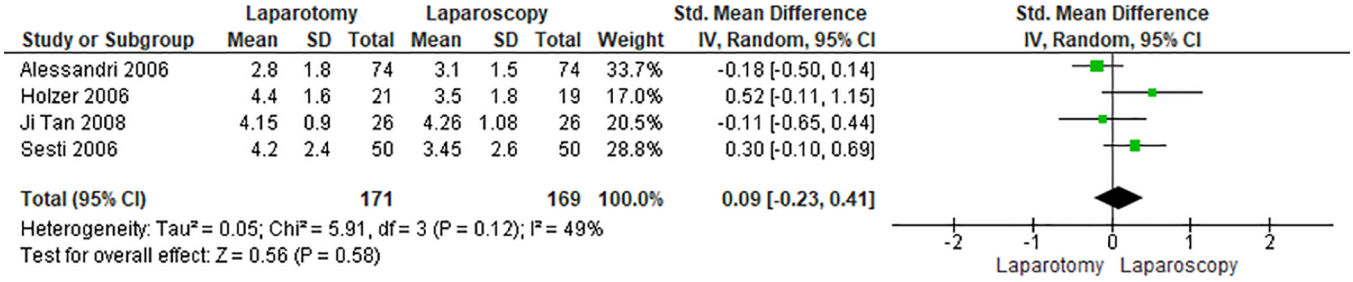

Fig. 8. Forest plot of comparison on postoperative pain incidence in 24 h after laparotomic myomectomy and laparoscopic myomectomy.

any statistically significant difference between the cohorts concerning pregnancy rate. The OR was 0.78 (95 % CI 0.42 to 1.45p =.43) **(**Fig. 9**).** Details about other obstetric outcomes, including uterine rupture, type of delivery, and the number of abortions were reported in two studies with a total of 388 patients [18,26]. In the laparotomic group, there were 37 cesarean deliveries and 11 vaginal deliveries, whereas in the laparoscopic group, there were 29 cesarean deliveries and 22 vaginal deliveries. However, statistical analysis did not reveal any significant differences between the two groups (OR: 1.16 [95 % CI 0.49 to 2.73p =.73] and OR: 0.42 [0.13 to 1.38p =.15], respectively) (Figs. S1 and S2). The rate of abortions was similar groups (OR: 0.51, 95 % CI 0.18 to 1.46, p =.21). No cases of uterine ruptures were reported either in two groups group [18,26] (Fig. S3).

Discussion

The present *meta*-analysis summarizes the highest-quality evidence available in the literature on the comparison of surgical outcomes in women with UL after laparoscopic myomectomy and laparotomic myomectomy. The pooled data analysis indicates that laparoscopic myomectomy offers several advantages, including shorter hospital stays, reduced blood loss and postoperative analgesic use compared with laparotomic approach. Nevertheless, there was no statistical difference in rate of intra-operative or post-operative complications between laparoscopic and laparotomic approach. Furthermore, no statistically significant difference emerged in the pregnancy rate and in other obstetrical outcomes.

Myomectomy is a widely performed surgical procedure employed for

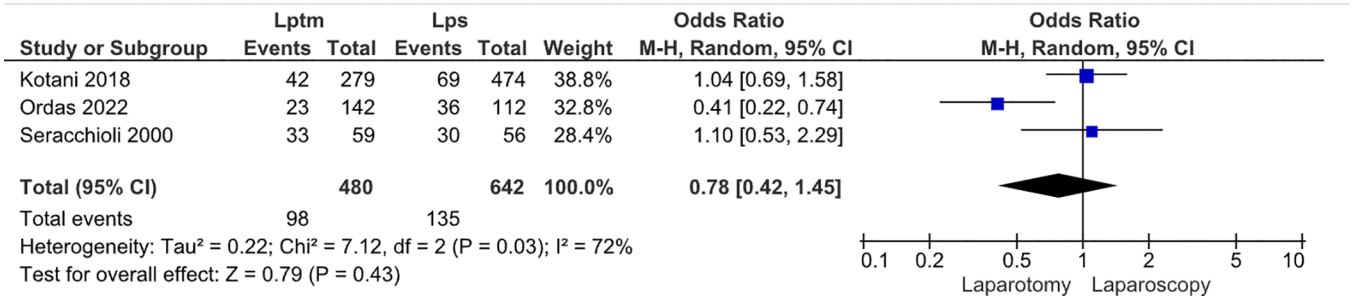

Fig. 9. Forest plot of comparison on pregnancy rate after laparotomic myomectomy and laparoscopic myomectomy.

the management of symptomatic UL. Over in the past few decades, laparoscopic surgery emerged as a prominent alternative to conventional laparotomic approach for myomectomy.

Laparoscopic surgery, involving the use of small abdominal incisions and fiber-optic instruments, facilitates the surgeon's ability to conduct the operation with greater visualization, precision, and good aesthetic outcome of the resulting scars [28].

Some authors have examined the evidence regarding the surgical outcomes of the two approaches, but the results have been conflicting. A prospective study analyzed 213 patients undergoing myomectomy and found no significant differences in surgical and clinical outcomes between laparoscopic and laparotomic surgery. [29]. Some authors reported a significantly reduced hemoglobin drop and blood loss, a shorter hospitalization, regarding operative complications rate [17,24,27,30]. Nevertheless, the laparoscopic approach for myomectomy is still a debated procedure for the potential limitation. Critical factors to consider are the surgeon's experience, the suitability of the patient, and the size, location, and number of uterine fibroids. Laparoscopic myomectomy, often require specialized surgical skills and training. Surgeons need to be proficient in using laparoscopic instruments and techniques. Inexperienced surgeons may face challenges when performing complex laparoscopic procedures, potentially leading to longer surgery times or increased risk of complications. Moreover, laparoscopy can be limited when dealing with large, multiple, or deeply located UL. The size and location can make it challenging to perform laparoscopic procedures. In such cases, abdominal surgery may be preferred because it provides the surgeon with more direct access and visibility.

One author, analyzed 444 patients, demonstrated that the size and type of UL serve as the most reliable indicators of surgical complexity and the potential for complications during and after surgery. Notably, when a patient presents with a minimum of two intramural or subserosal UL, with at least one exceeding 8 cm in size, it may be advisable to consider a laparotomic approach as the preferred surgical method [18]. Furthermore, it is important to consider that studies designed for laparoscopic myomectomy often have stringent inclusion criteria, thereby limiting the assessment of more challenging cases. Most studies focus on patients with fibroids smaller than 10 cm or with three to four fibroids. In any case, the most widely recognized contraindications to diagnostic laparoscopy are: Multiple fibroids, more than three fibroids measuring $>$ 7 cm, uterine volume $>$ 20 gestational weeks, single fibroid $>$ 15 cm, women who have completed their reproductive cycle and desire hysterectomy, any medical condition contraindicating prolonged anesthesia for laparoscopic surgery [31].

A growing body of evidence suggests that minimally invasive surgical procedures tend to incur higher costs compared to abdominal surgery [32]. However, it's important to consider the advantages offered to patients, shorter recovery periods, and a quicker return to work [32,18]. These factors may exert a notable influence on the overall societal costs associated with treatment. [32,21].

The selection between these two surgical approaches should be decided upon a comprehensive evaluation of the patient's clinical profile, UL characteristics (number, size and location), surgeon proficiency, and available resources. The principal objective is the attainment of an optimal therapeutic outcome, with a judicious balance between risk reduction and patient benefit.

Another point deserving attention is the role of intra-abdominal morcellation in undiagnosed uterine sarcoma [33,34]. Although rare, we have to take into account that morcellation of undiagnosed uterine sarcoma might be related to worse oncologic outcomes for those patients (upstaged from stage I to stage IV due to dissemination of uterine malignancies). In the current scenario, in-bag morcellation should be used during minimally invasive myomectomy [34,35], however, a comprehensive counseling of the patient, stating that there is currently no Level I evidence that endobag morcellation can reduce the risk of spillage of any potential occult sarcoma, must be clearly conducted.

In addition, the uterine cavity exploration by hysteroscopy could be useful in preoperative time [36,37]. The study of endometrial cavity and the possibility to perform targeted biopsies, could help in choosing the most correct surgical approach [38].

The strengths of this *meta*-analysis are as follows: first, this work represents the most up-to-date *meta*-analysis aiming to establish the advantages and disadvantages of laparoscopic and laparotomic myomectomy, in order to tailor surgical therapy by selecting patients appropriately. Second, more than half of studies *meta*-analyzed, seven were randomized trials. Third, the sub-analysis includes the main surgical outcomes to be considered for a comprehensive evaluation of the two surgical approaches analyzed, by assessing individual values of mean differences and odds ratio according on the various outcomes. In addition, the main studies present in the literature were included, respecting the inclusion criteria to obtain uniform results from the statistical analysis.

The present *meta*-analysis has some limitations. First, in some included studies, the surgeon have chosen the myomectomy approach according to indications, surgical experience and patient characteristics such as the number, size and location of UL. The surgeon's experience affects all the outcomes analyzed, although the skills of the operators is not known (or at least clearly defined) for all studies. Second, patients' characteristics such as size, number, and location of UL were not reported in all studies. Third, those studies did not take into account the need to perform in-bag morcellation. This feature might influence the operative variables (in particular operative time) of the current adopted laparoscopic approach.

Conclusion

Laparoscopic myomectomy, compared with laparotomic myomectomy, was associated with significantly shorter hospitalization days, postoperative analgesic use and estimated blood loss. The laparoscopic approach could be a valid alternative to laparotomic one, in selected patients. Therefore, more well-designed studies or large population program data to draw definitive conclusions are therefore warranted.

Funding

The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Patient consent for publication

Not applicable.

CRediT authorship contribution statement

Andrea Giannini: Visualization, Resources, Project administration, Methodology, Formal analysis, Conceptualization. **Ilaria Cuccu:** Writing – original draft, Software, Investigation, Formal analysis, Data curation. **Tullio Golia D'Auge:** Writing – original draft, Investigation, Data curation. **Emanuele De Angelis:** Writing – original draft, Investigation, Data curation. **Antonio Simone Laganà:** Supervision, Methodology. **Vito Chiantera:** Supervision. **Donatella Caserta:** Supervision. **Salvatore Giovanni Vitale:** Visualization, Validation. **Ludovico Muzii:** Validation, Conceptualization. **Ottavia D'Oria:** Formal analysis. **Giorgia Perniola:** Supervision, Software. **Giorgio Bogani:** Validation, Project administration, Conceptualization. **Violante Di Donato:** Visualization, Supervision, Project administration, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability statement

All data relevant to the study are included in the article or uploaded as supplementary information

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejogrb.2024.03.045.

References

[1] Ming X, Ran XT, Li N, Nie D, Li ZY. Risk of recurrence of uterine leiomyomas following laparoscopic myomectomy compared with open myomectomy. Arch Gynecol Obstet 2020;301(1):235–42.
[2] Sami Walid M, Heaton RL. The role of laparoscopic myomectomy in the management of uterine fibroids. Curr Opin Obstet Gynecol 2011;23(4):273–7.
[3] Chang CC, Chen W. A comparison of surgical outcomes between laparoscopic and open myomectomy in southern Taiwan. Int J Gynaecol Obstet 2012;119(2):189–93.
[4] Lumsden MA. Embolization versus myomectomy versus hysterectomy: which is best, when? Hum Reprod 2002;17(2):253–9.
[5] Munro MG, Critchley HO, Broder MS, Fraser IS. FIGO working group on menstrual Disorders. FIGO classification system (PALM-COEIN) for causes of abnormal uterine bleeding in nongravid women of reproductive age. Int J Gynaecol Obstet 2011;113(1):3–13.
[6] Gomez E, Nguyen MT, Fursevich D, Macura K, Gupta A. MRI-based pictorial review of the FIGO classification system for uterine fibroids. Abdom Radiol (NY) 2021;46(5):2146–55.
[7] Knipe H, El-Feky M, Rasuli B, FIGO classification system for uterine leiomyoma. Reference article, Radiopaedia.org.
[8] Vilos GA, Allaire C, Laberge PY, Leyland N. Special contributors. The management of uterine leiomyomas. J Obstet Gynaecol Can 2015;37(2):157–78.
[9] Matta WH, Shaw RW, Nye M. Long-term follow-up of patients with uterine fibroids after treatment with the LHRH agonist buserelin. Br J Obstet Gynaecol 1989;96(2):200–6.
[10] Bhave Chittawar P, Franik S, Pouwer AW, Farquhar C. Minimally invasive surgical techniques versus open myomectomy for uterine fibroids. Cochrane Database Syst Rev. 2014 Oct 21;(10):CD004638.
[11] Jin C, Hu Y, Chen XC, et al. Laparoscopic versus open myomectomy–a meta-analysis of randomized controlled trials. Eur J Obstet Gynecol Reprod Biol 2009;145(1):14–21.
[12] Shin DG, Yoo HJ, Lee YA, Kwon IS, Lee KH. Recurrence factors and reproductive outcomes of laparoscopic myomectomy and minilaparotomic myomectomy for uterine leiomyomas. Obstet Gynecol Sci 2017;60(2):193–9.
[13] Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;29(372):n71.
[14] Higgins JPT, Thomas J, Chandler J, et al. Cochrane Handbook for Systematic Reviews of Interventions version 6.4 (updated August 2023). Cochrane, 2023. Available from www.training.cochrane.org/handbook.
[15] Sterne JA, Hernán MA, Reeves BC, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ 2016;12(355):i4919.
[16] Sterne JAC, Savović J, Page MJ, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ 2019;366:l4898.
[17] Kalogiannidis I, Prapas N, Xiromeritis P, Prapas Y. Laparoscopically assisted myomectomy versus abdominal myomectomy in short-term outcomes: a prospective study. Arch Gynecol Obstet 2010;281(5):865–70.
[18] Ordás P, Spagnolo E, Fernández LG, et al. Comparison of surgical and obstetric outcomes in women with uterine leiomyomas after laparoscopic vs. abdominal myomectomy: a single-center cohort study. Front Surg 2022 Dec;26(9):997078.
[19] Catanese A, Siesto G, Cucinella G, et al. Factors influencing surgical outcomes of laparoscopic myomectomy. A propensity-score matched analysis. Prz Menopauzalny 2022;21(3):149–56.
[20] Kotani Y, Tobiume T, Fujishima R, et al. Recurrence of uterine myoma after myomectomy: open myomectomy versus laparoscopic myomectomy. J Obstet Gynaecol Res 2018;44(2):298–302.
[21] Holzer A, Jirecek ST, Illievich UM, Huber J, Wenzl RJ. Laparoscopic versus open myomectomy: a double-blind study to evaluate postoperative pain. Anesth Analg 2006;102(5):1480–4.
[22] Mais V, Ajossa S, Guerriero S, Mascia M, Solla E, Melis GB. Laparoscopic versus abdominal myomectomy: a prospective, randomized trial to evaluate benefits in early outcome. Am J Obstet Gynecol 1996;174(2):654–8.
[23] Sesti F, Capobianco F, Capozzolo T, Pietropolli A, Piccione E. Isobaric gasless laparoscopy versus minilaparotomy in uterine myomectomy: a randomized trial. Surg Endosc 2008;22(4):917–23.
[24] Cicinelli E, Tinelli R, Colafiglio G, Saliani N. Laparoscopy vs minilaparotomy in women with symptomatic uterine myomas: a prospective randomized study. J Minim Invasive Gynecol 2009;16(4):422–66.
[25] Tan J, Sun Y, Dai H, Zhong B, Wang D. A randomized trial of laparoscopic versus laparoscopic-assisted minilaparotomy myomectomy for removal of large uterine myoma: short-term outcomes. J Minim Invasive Gynecol 2008;15(4):402–9.
[26] Seracchioli R, Rossi S, Govoni F, et al. Fertility and obstetric outcome after laparoscopic myomectomy of large myomata: a randomized comparison with abdominal myomectomy. Hum Reprod 2000;15(12):2663–8.
[27] Alessandri F, Lijoi D, Mistrangelo E, Ferrero S, Ragni N. Randomized study of laparoscopic versus minilaparotomic myomectomy for uterine myomas. J Minim Invasive Gynecol 2006;13(2):92–7. https://doi.org/10.1016/j.jmig.2005.11.008. PMID: 16527709.
[28] Dumitrascu MC, Nenciu CG, Nenciu AE, et al. Laparoscopic myomectomy - the importance of surgical techniques. Front Med (Lausanne) 2023;20(10):1158264.
[29] Fanfani F, Fagotti A, Bifulco G, Ercoli A, Malzoni M, Scambia G. A prospective study of laparoscopy versus minilaparotomy in the treatment of uterine myomas. J Minim Invasive Gynecol 2005;12(6):470–4.
[30] Saccardi C, Gizzo S, Noventa M, Ancona E, Borghero A, Litta PS. Limits and complications of laparoscopic myomectomy: which are the best predictors? a large cohort single-center experience. Arch Gynecol Obstet 2014;290(5):951–6.
[31] Dubuisson JB, O'Leary T, Feki A. Bouquet DE jolinière J, dubuisson J. Laparoscopic myomectomy. Minerva Ginecol 2016;68(3):345–51.
[32] Behera MA, Likes 3rd CE, Judd JP, Barnett JC, Havrilesky LJ, Wu JM. Cost analysis of abdominal, laparoscopic, and robotic-assisted myomectomies. J Minim Invasive Gynecol 2012;19(1):52–7.
[33] Giannini A, Golia D'Augè T, Bogani G, et al. Uterine sarcomas: a critical review of the literature. Eur J Obstet Gynecol Reprod Biol 2023;17(287):166–70.
[34] Bogani G, Chiappa V, Ditto A, et al. Morcellation of undiagnosed uterine sarcoma: a critical review. Crit Rev Oncol Hematol 2016;98:302–8.
[35] Bogani G, Uccella S, Cromi A, et al. Electric motorized morcellator versus transvaginal extraction for myoma retrieval after laparoscopic myomectomy: a propensity-matched analysis. J Minim Invasive Gynecol 2014;21(5):928–34.
[36] Chiofalo B, Palmara V, Vilos GA, et al. Reproductive outcomes of infertile women undergoing "see and treat" office hysteroscopy: a retrospective observational study. Minim Invasive Ther Allied Technol 2021;30(3):147–53.
[37] Vitale SG, Laganà AS, Török P, et al. Virtual sonographic hysteroscopy in assisted reproduction: a retrospective cost-effectiveness analysis. Int J Gynaecol Obstet 2022;156(1):112–8.
[38] Vitale SG, Laganà AS, Caruso S, et al. Comparison of three biopsy forceps for hysteroscopic endometrial biopsy in postmenopausal patients (HYGREB-1): a multicenter, single-blind randomized clinical trial. Int J Gynaecol Obstet 2021;155(3):425–32.